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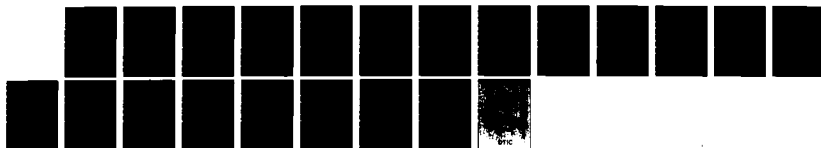
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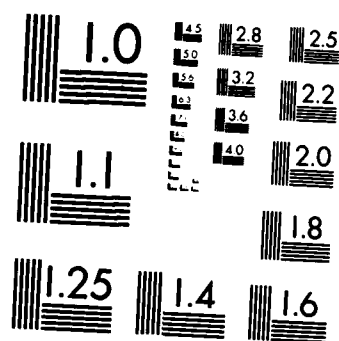
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Effects of Four Task Stressors on Blood Pressure
Responses in Persons Differing in Type A Coronary Prone
Behavior and Cognitive Complexity

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It has been widely accepted for some time that physiological arousal is likely to modify behavior, including task performance. The demonstration that behavioral styles can influence arousal which, in turn, would affect task related behavior is much more recent. There no longer is any doubt that Type A Coronary Prone Behavior affects physiological responsivity. More recently, researchers have demonstrated that cognitive complexity is a predictor of arousal (Streufert, Streufert, Dembroski and MacDougall, 1979) and of arousal related task performance (Streufert, Streufert and Denson, 1982) as well. These findings suggest the need for a more detailed examination of the arousal levels that might be expected for a number of different tasks by persons differing in Type A coronary prone behavior and in cognitive complexity. The procedure to be utilized in this research will follow that previously employed by Streufert, Streufert, Lewis, Henderson and Shields (1982) and Streufert, Streufert, Denson, Lewis, Henderson and



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Shields (in press), with individual differences in Type A and cognitive complexity introduced as additional variables. For the present purpose, the analysis will be limited to differences in physiological responsivity across task conditions. If findings are obtained which suggest Type A- or complexity-mediated differences in arousal, additional research on the interactive effects of these variables with specific kinds of task performance would become important.

Research on Physiological Responsivity to Task Environments

Until recently, it remained unclear, whether human physiological responses in general and cardiovascular responses in particular to various work environments would differ only in degree (for example, the level of blood pressure elevations) or would also differ in kind (i.e. diverse kinds of arousal might be obtained across different kinds of stressors and different kinds of tasks.) A great deal of previous research has suggested that different tasks are likely to produce a variety of diverse levels of blood pressure and heart rate elevations. For example, landing aircraft, performing arithmetic and taking medical school examinations all produce specific levels of measured physiological (blood pressure elevation) arousal (e.e., Andrienn and Hansson, 1981; Bassan, Marcus and Ganz, 1980; Bonelli, Hortnagl, Brucke, Lochs and Kaik, 1979; Roscoe, 1978; Rush, Shepherd, Webb and Vanhoutte, 1981; Sime, Buel and Eliot, 1980). Nonetheless, some researchers have obtained results which suggested that differences among tasks might be reflected not only in different levels, but also in different

kinds* of arousal responses. For example, Danner, Endert, Koster and Dunning (1981) found that students about to take a medical school examination presented with elevated diastolic blood pressure, unchanged systolic blood pressure and decreased heart rate. Cacioppo and Sandman (1978) presented their subjects with cognitive tasks (arithmetic, string memorization and anagrams) and with an unpleasant visual task (watching slides of an autopsy). While heart rate showed an increase in the cognitive tasks, it decreased upon presentation of the autopsy slides.

Discrepancies in cardiovascular reactivity such as these may lead us to search for potential differences among stressors as they affect human physiologic responsivity or as they interact with tasks, environments and social settings to produce specific responses. In other words, differential physiological responses (e.g., peripheral vascular resistance vs. increase in heart rate or output) might be due to specific stressor types which would need to be identified. However, one may also propose a quite different set of reasons for the divergent data mentioned above. The obtained discrepancies might, for example, be due to individual differences, i.e., the type of persons represented in the samples of specific researchers. Considerable data on differences among individuals of diverse characteristics in their reactions to (equally diverse) stressors have been collected. For example, Vessel and Laux (1978) have shown that persons adapt to stressors, even if

*Differences in kind would be reflections of diverse physiological mechanisms operating under specific task (stressor) conditions. For example, while one task may produce central arousal another might result in peripheral vascular constriction, etc. Differential levels of measured arousal, e.g. in systolic vs. diastolic elevations, may be a reflection of these differences.

previously presented in a different mode, and will show less physiological arousal (cardiovascular responsivity) to subsequent stressors. Other researchers have demonstrated that a number of cognitive styles affect the degree to which altered cardiovascular hemodynamics are obtained (e.g., Gaines, Smith and Skolnik, 1977; Kelsall and Strongman, 1978; Streufert, Streufert, Demobroski and MacDougall, 1979; Woods, 1977). Attempts have been made to relate certain personality variables to cardiovascular arousal as well (e.g., Hinton and Craske, 1977; VanIm Schoot, Liesse, Mertens and Lauwers, 1978). The large volume of research on the Type A coronary prone behavior individual and his/her exaggerated reactivity is now very well known (e.g., Dembroski, Weiss, and Shields, 1978). Elevated cardiovascular responsivity to certain stressors may also be aggravated by specific work or job characteristics. Sime et al. (1980), for example, report data indicating that blood pressure was considerably higher for executives as compared to non-executives in their sample. Finally, cardiovascular hemodynamics may be affected by recently taken medication, particularly beta blockers, and other drugs used to decrease the autonomic neural effects on the cardiovascular system. Specifically, heart rate elevations to stress appear to be diminished or eliminated while elevations in blood pressure often persist (e.g., Bonelli, et al. 1979; Dunn, Lorimer and Lawrie, 1979; Heidbrenner, Pagel, Rockel and Heidland, 1978; Nakano, Gillespie and Hollister, 1978).

While the previous data indicating discrepant types of responsivity to diverse stressor conditions was suggestive, they were hardly conclusive. As long as data was obtained with diverse tasks, different subject populations, diverse experimental settings and somewhat varying measurement techniques,

one could not be certain that those studies reporting disparate physiological types of responsivity were reliable and valid, especially in the face of the larger number of research efforts that reported differences in degree, but not in kind of response. Moreover, one could not be certain that the obtained differences in the kind of physiological response stemmed from settings that are even remotely related to standard work environments. A reliable test of the question as to whether different stressor conditions do produce physiological (here, cardiovascular) responsivity which varies not only in degree but also in kind required that measurement methods and external environment would be held constant, and that responsivity to a number of different stressors would be obtained from the same group of subjects, performing tasks that are similar to tasks that may occur in work environments. Some initial efforts in this direction (although often not particularly relevant to work environments) have been reported. For example, Andrien and Hansson (1981) exposed their subjects to both cold pressor and arithmetic tasks. While they obtained increased blood pressure in both tasks, only heart rate increased on the arithmetic task. Rush et al. (1981) measured cardiovascular reactivity during physical exercise and mental stress with essentially similar results. Light and Obrist (1980), on the other hand, found that persons reacting with specific arousal in one task would react similarly in other tasks. As already mentioned, Cacioppo and Sandman (1978) obtained diverse arousal measures in unpleasant visual as compared to unpleasant cognitive tasks. Discrepancies of this nature have led some researchers to conclude that effects of stressors are likely highly

specific and may well depend on the kind of stressor and the kind of task employed (Lulofs, Wennekens and VanHoutem, 1981) and may function via totally different hemodynamic mechanisms (Andrien and Hansson, 1981).*

Individual Differences in Task Relevant Physiologic Response

It was suggested above that the apparent differences in kind of physiological response to stressor or task impact which have been obtained maybe due to (1) task/stressor differences themselves, or (2) individual differences in responding to tasks and task stressors. The first of these two possibilities was investigated by Streufert, Streufert, Lewis Henderson and Shields (1982) and Streufert, Streufert, Denson, Lewis, Henderson and Shields (in press). These authors designed a study in which systolic blood pressure, diastolic blood pressure and heart rate changes were systematically compared across four diverse stressor conditions which differed in content and in setting. While all "social" tasks resulted in approximately equivalent increases (at diverse levels) in systolic blood pressure and diastolic blood pressure, a non-social (visual-motor) task resulted in quite different elevations for the same subjects. In other words, these authors demonstrated that differences in degree and kind may be expected due to variations in tasks.

A careful look at the data of Streufert et al (1982), however, points toward a bi-modal distribution of blood pressure elevations for the visual-motor task, suggesting that potential individual difference variables

*Researchers concerned with hormonal responses (e.g., Frankenhauser, 1975; Frankenhauser, vonWright, Collins, vonWright, Sedvall and Swahn, 1976) have obtained data that would argue, at least in part, for non-uniformity of the human stress reaction as well (c.f. also Singer, 1980).

may have affected arousal. Such differences would be reflective of the second of the two questions raised above. Can specific individual difference variables be identified that might account for some of the variance in kind as well as level of hemodynamic elevations in response to task stressor impact? Two stylistic variables (see the discussion above) suggest themselves because of their previous successful utilization in relevant research efforts: Type A coronary prone behavior and cognitive complexity. Both have been shown to relate to arousal. The present research will test the degree to which these variables may be involved in task related hemodynamic responsivity. For the purpose of comparison to the previous research effort of Streufert et al (1982), the same research method will be employed.

METHOD

Stressor Conditions

Five different stressor conditions were employed. They were selected to differ in the degree of potential stress, in the social vs. non-social environment in which they occurred, and in the kind of behavior/performance that was required. All stressors were selected to allow precise control of experimental manipulation, yet to have similarity to work environments with which they might be compared. The following conditions were utilized:

Non-social baseline: resting alone, probably not unlike the coffee break taken in a private setting. The following four conditions were compared to this condition; differences are expressed as delta values which are used as the basis for data analysis (see above).

Social baseline: resting in the presence of another person, probably not unlike the coffee break taken with others present but without interaction with them.

Complexity interview: a task in which a social interchange on non-self selected topics occurs, yet in a pleasant, open interpersonal atmosphere. The complexity interview is based on the sentence completion task on which extensive validity and reliability data, as well as administrative requirements, are available.

Type A interview: a task in which social interchange on non-self selected topics occurs, yet in an unpleasant, challenging interpersonal atmosphere, not unlike the interaction with a somewhat hostile demanding boss. Again, extensive reliability and validity data as well as administration requirements are available.

Video game task: a non-social, task-oriented setting in which the person works alone against different levels of experimentally scaled and controlled challenges, experiencing both potential success and failure in the task setting. The task is similar to many hand-eye coordination tasks found in work environments.

The following section will discuss how these tasks were employed in the research.

Procedure

Forty-two adult male paid volunteers participated as individuals in a series of tasks. Total time spent in the experimental setting was approximately four hours per person. Upon arrival at the laboratory, each subject was individually briefed about the forthcoming events. His signature on a

consent form was obtained. Subjects were then taken to one of two identical experimental rooms. The experimental procedure began when the experimenter attached a blood pressure cuff to the dominant arm. The cuff allowed the experimenter to measure systolic blood pressure and diastolic blood pressure at two-minute intervals.*

The experimenter then sat at a desk across from the subject and asked a number of biographic questions. Responses to the questions were recorded by the experimenter on a data sheet. Upon completion of the biographic questionnaire, the subject was asked to sit back and relax for a few minutes. The experimenter remained in the room and quietly worked on organizing a set of papers.

Complexity Interview

After approximately six minutes, the experimenter handed the subject a set of cards. Each card contained the stem of a sentence (e.g. When someone competes with me...). The subject was asked to complete the sentence and add several additional sentences on the same topic. After the subject completed his responses to the card, the experimenter asked several non-leading, non-directive questions, encouraging the subject to continue his statements on the topic at hand. When the subject's repertoire of responses to each topic was exhausted, he was asked to go on to the

Measurements were taken automatically by a Vitastat 900D and recorded on tape. Alarms were sounded when blood pressure would exceed 200 mm Hg systolic. Two successive readings at this level were considered dangerous and would have resulted in excluding the subject from further participation in the research. No such readings were, however, obtained.

following card. A total of 12 cards was presented. The procedure represents an interview version of the sentence completion test (Schroder and Streufert, 1963; Schroder, Driver and Streufert, 1967) designed to measure cognitive complexity. The behavior and responses of the experimenter allowed the subjects to "open up" and present their significant thoughts and feelings to another person. Responses of the subjects were recorded on videotape for later analysis. Physiological measurement procedures during this and other parts of the research will be discussed below in the section on measurement.

Type A Interview

Following the complexity interview, the original experimenter left the room and a second experimenter entered and administered the Type A Structured Interview developed by Rosenman and Friedman (c.f. Rosenman, 1978) to measure coronary prone behavior. The interview represents a standardized social challenge situation considered by many to exemplify severe social stress. The responses of subjects were again videotaped. After completion of the interview, the blood pressure cuff was removed from the subject's arm to allow him the freedom to write. The subject was then asked to respond to a paper-and-pencil questionnaire (of no interest to this paper).

Collection of Non-social Baseline Data

Upon completion of the questionnaire, the subject was escorted to another (identical) experimental room. A blood pressure cuff was attached to the non-dominant arm and the subject was instructed to watch a video

screen. After the experimenter left the room, videotaped instructions for a video game (similar to Pac Man) were presented on the screen. Instructions were detailed enough to allow all subjects, including those who had no previous experience with video games, to understand the task. The task itself was selected for its general interest across divergent groups of potential subjects and because it did not rely on considerable previous experience with video games. Once the subject had completed watching the instructions, he was asked to sit back and relax for a few minutes while a kaleidoscopic display of colors slowly unfolded on the video screen in front of him. Subjects spent several minutes watching the kaleidoscope.

Visual-Motor Task

The video game began with a practice period with a slow speed and low difficulty level, allowing even the uninitiated to perform better than the average performance score* obtained at first play by previous participants. Following the practice period, subjects rated the difficulty level of the task on a seven-point scale and then sat back (as instructed) to once more relax for a few minutes. Ratings and relaxation periods were introduced following each of the five game periods. The four game periods following the practice period were systematically varied in difficulty level (in random order) from relatively easy (little or no stress) to very difficult (moderately high stress). Perceptions of difficulty matched the experimentally introduced difficulty levels. Even those unfamiliar with video

*The average performance score was provided on the video screen throughout the practice period. The maximum performance score was provided throughout all subsequent periods.

games found the easy task level to optimal and even those who reported considerable experience with video games found the most difficult task level to be very difficult. None of the subjects reached the maximum score obtained by the most successful previous participants when they were dealing with the most difficult task level. At the completion of the video game visual-motor task, subjects were again asked to sit back and relax for a few minutes. Finally, the experimenter reentered the room, removed the blood-pressure cuff and instructed the subject to complete another paper-and-pencil questionnaire. Following the completion of that questionnaire, subjects were debriefed, paid and released.

The task sequence described above held for twenty-nine of the subjects. The remaining thirteen subjects were exposed to the experimental procedure in the inverse order (paper-and-pencil questionnaire followed by video-game, questionnaire, Type A interview, complexity interview, and biographic questions, with rest periods appropriately interspersed). No differences in any performance or physiological response measures due to order of presentation could be discovered.

Measurement

Measurements of systolic blood pressure and diastolic blood pressure were taken throughout the sequence of tasks at two-minute intervals (except when subjects were working on questionnaires). Measurements for the rest period between the biographical and the complexity interview (here called social baseline), for the complexity interview, the Type A interview, and the four (non-practice) playing periods of the game were employed as the units of analysis for this research. Measurements during these task

conditions were limited to four measurements at two-minute intervals to limit the compression of subjects' arms. Measurements for each of the task conditions were averaged to obtain a single score and compared with non-social baseline values (obtained while subjects were watching the kaleidoscopic pictures* on the T.V. screen). Discrepancies between the four task levels and the resting levels were expressed as mean delta values.

The Type A interview was scored according to the procedures developed by Rosenman, Friedman and associates. Both scorers were trained by Rosenman. Discrepancies in assigned score values did not exceed one point and were resolved by discussion. The complexity interview was scored according to procedures developed by Streufert and Streufert. The developers of the procedure did the scoring, discrepancies between assigned score values did not occur. As a result of the scoring procedures, 12 subjects were identified as less Cognitively Complex (i.e. undimensional) Type A, 12 subjects were identified as Cognitively Complex (i.e. multidimensional) Type A, 9 subjects were placed into the less Cognitively Complex (i.e. multidimensional) Type B category, and 8 subjects were placed into the Cognitively Complex (i.e. multidimensional) Type B category. One subject was not categorized since he both fell between Type A and Type B (Type X) and was marginal in the categorization based on the interview for cognitive complexity. Data analysis was based on the forty-one remaining subjects.

*Non-social baseline levels were also obtained at the end of the experimental sessions and for the resting periods between the game periods. Data analysis indicated no differences in systolic or diastolic blood pressure among these various non-social baseline conditions.

Results and Discussion

"Delta values" for systolic blood pressure and diastolic blood pressure discrepancies form non-social baseline values were calculated for the social baseline measure, the four complexity interview measures, the four Type A interview measures and the number of measures obtained during the visual motor task (at least ten). Delta values for measures within each of the interviews and within the task were averaged to a single score for each subject. Standard deviations for tasks where multiple discrepancies were obtained (Complexity, Type A, Task) were recorded as well.

The data were analyzed with mixed design ANOVA procedures, separately for mean deltas and for standard deviations of deltas. Factors in analyses were Complexity (two levels, between), Type A (two levels, between), Blood Pressure (two levels, within) and Tasks (four levels, within, for the blood pressure delta elevation analysis, and three levels, within, for the standard deviation analysis). We will initially report and discuss the results of the first ANOVA procedure.

A significant main effect for tasks was obtained ($F = 22.65$, 3/111 df, $p < .001$). Blood pressure elevations were highest during the complexity interview, somewhat lower during the Type A interview (16.75 vs. 12.5 mm Hg), yet lower during the visual-motor task (8.9 mm Hg) and hardly elevated during the social baseline measurement (5 mm Hg). The familiar interaction of blood pressure with tasks reported by Streufert et. al. (1982) was again

obtained*, indicating that the different tasks produced diverse levels and kinds of physiological response ($F = 4.03$ 3/111 df, $p = .009$). No other significant main effects or interactions were observed in this analysis. Apparently neither Type A nor cognitive complexity contributed to differences in arousal delta values.

So far, the obtained data do not provide any additional information beyond that reported in the earlier research. Type A and cognitive complexity did not predict or explain individual differences in mean blood pressure elevations across tasks.

Glass (1977) has argued that research may need to focus not only on the elevations of blood pressure as an indicator of stress response, but also on variability of that response. For that purpose, the interviews and the visual-motor task (where a number of measurements were taken) were subjected to an ANOVA based on the obtained standard deviation scores. The social baseline measure could not be included, since blood pressure readings had been obtained only once during that period.

Significant F ratios were obtained for blood pressure (systolic vs. diastolic, $F = 6.758$, 1/27 df, $p = .012$, with systolic blood pressure showing generally greater variability); the various tasks ($F = 15.35$, 2/74

*The previously reported data of Streufert et. al. (1982) and Streufert et.al. (in press) found slightly higher systolic than diastolic elevations for the social baseline and interview measurements, but the inverse for the visual motor task. While differential levels for tasks and interaction of blood pressure with tasks is replicated here, the obtained patterns of systolic vs. diastolic elevations appear to differ. In the present data diastolic elevations exceed systolic elevations for the interviews, with greater systolic elevation for the visual motor task. Apparently a bimodal distribution of elevations is responsible. That bimodality is, however, not explained by either Type A or by cognitive complexity.

df, $p < .001$, to be discussed in terms of interaction, below); the Type A by task interaction ($F = 3.69$, $2/74$ df, $p = .029$, with Type A persons responding with especially large variability in the Type A interview); and the Complexity by Type A by Tasks interaction ($F = 6.50$, $2/74$ df, $p = .002$, indicating that the greater variability of Type A persons to the Type A interview was limited to cognitively complex (multidimensional persons). A marginal F ratio for the four way interaction ($F = 2.56$, $2/74$ df, $p = .082$) will be ignored for the purposes of this paper since it tends to account for very little variance.

The data indicate that Type A coronary prone behavior and cognitive complexity do affect physiological responsivity differences to various work related tasks, but do so in terms of response variability more than in response level. In addition, the two individual difference variables appear to interact with each other, as indicated in Figure 1. A view of that figure suggests that in general, variability was highest in the complexity interview, the same task which had resulted in the highest delta levels (reported above). Slightly lower levels were generally obtained in the Type A interview, followed by yet lower elevations for the visual-motor task. However, that general pattern did not hold for the multidimensional Type A subjects. This group produced excessive blood pressure variance during the Type A interview, and lesser variability during the complexity interview, followed by the visual-motor task. In contrast, Simple Type A persons responded in the same fashion observed for the other groups in the analysis.

Another unusual response was obtained from multidimensional subjects, in this case, however, from the Type B group. Excessive arousal variability occurred for these persons during the complexity interview. This finding

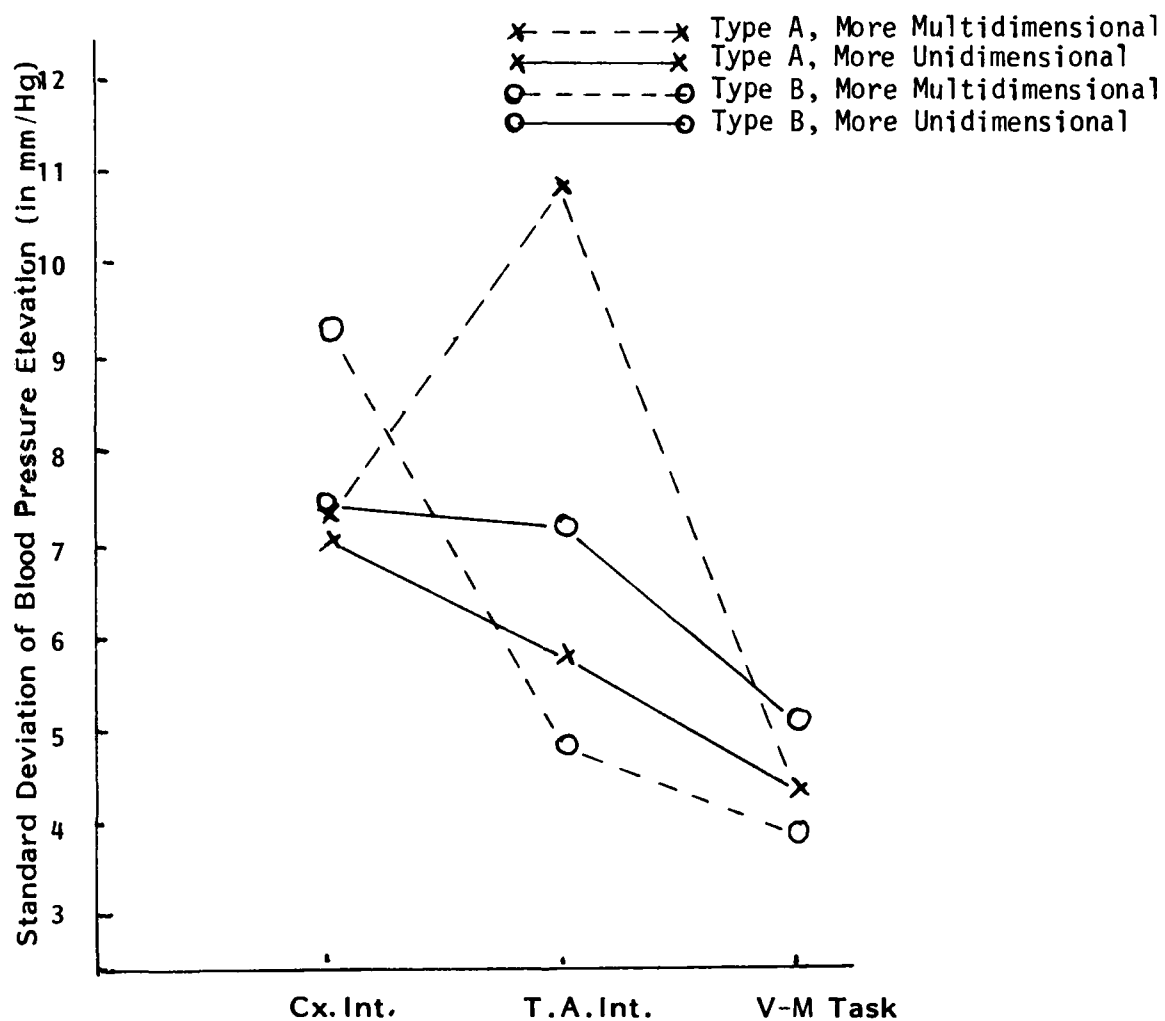


FIGURE 1. Effects of Individual Differences in Cognitive Complexity and Type A Coronary Prone Behavior on Blood Pressure Variability during the Type A Interview, The Complexity Interview and a Visual-Motor Task.

replicates previous (yet unpublished) observations that Type B multidimensional persons tend to be hyperresponsive (usually with diastolic blood pressure elevations or variability) in non-social stressful tasks and in cooperative social settings.

The data suggest that Type A and Cognitive complexity do show some relationship to arousal across a number of tasks. The finding that different task environments result in different levels and kinds of cardiovascular responsivity was replicated. Responsivity, in terms of blood pressure elevations and/or variability appears to be greater for cognitively complex i.e. multidimensional than for more undimensional persons. While Type A multidimensional persons appear to be particularly responsive to a stressful social tasks (Type A interview), Type B multidimensional persons appear to be particularly responsive to cooperative social tasks and (as demonstrated in yet unreported efforts on this research project) to non-social task environments. A more detailed exploration of the interactive effects of Type A and cognitive complexity in response to various task stressors as they affect performance (in addition to physiological arousal) appears warranted.

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